
Section 3

Pekin Lake Plan Formulation

DESCRIPTION OF THE STUDY PROCESS

Development of the Pekin Lake Feasibility study followed the Corps of Engineers' six-step planning process specified in the Engineer Regulation (ER) 1105-2-100. The process identifies and responds to problems and opportunities associated with the Federal objective and specified state and local concerns. The process provides a flexible, systematic, and rational framework to make determinations and decisions at each step so that the interested public and decisions makers are fully aware of the basic assumptions employed; the data and information analyzed; the areas of risk and uncertainty; and the significant implications of each alternative plan. If a Federal and state interest are identified, the process culminates in the selection of a plan to be recommended to Congress for implementation.

As part of identifying the selected plan, a number of alternative plans are developed and compared with the no "action alternative", allowing for the ultimate identification of the National Ecosystem Restoration (NER) Plan. The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. In addition to considering the system benefits and costs, it will also consider information that cannot be quantified such as environmental significance and scarcity, socioeconomic impacts, and historic properties information.

The steps used in the plan formulation process include:

1. **Identify Problems and Opportunities:** The specific problems and opportunities are identified, and the causes of the problems discussed and documented. Planning goals are set, objectives established, and constraints identified.
2. **Inventory and Forecast Resource Conditions:** This characterizes and assesses conditions in Pekin Lake as it currently exists and forecasts the most probable without-project condition (or "no action" alternative) over the period of analysis. This assessment gives the basis by which to compare various alternative plans and their impacts. The without-project condition is what the lake and its uses are anticipated to be like over the 50-year planning period without any restoration implemented as a result of this study. The with-project condition is what the lake and its uses are anticipated to be if restoration measures are implemented.
3. **Formulate Alternative Plans:** Alternative plans are developed in a systematic manner to ensure that reasonable alternatives are evaluated. In addition to the no action alternative, restoration alternatives in the lakes will be considered.

4. Evaluate Alternative Plans: The evaluation of each alternative consists of measuring or estimating the environmental benefits (Habitat Units), costs, technical considerations, and social effects of each plan, and determining the difference between the without and with-project conditions. A key measure of the evaluation of alternative plans is a cost-effectiveness incremental cost analysis and evaluation of significance.

5. Compare Alternative Plans: Alternative plans are compared, focusing on the differences among the plans identified in the evaluation phase and public comment. As part of the evaluations, the “best buy” plans are identified—those plans that provide the greatest increase in benefits for the least increase in cost.

6. Select Recommended Plan: A Recommended Plan is selected and justified for plan selection. If a viable plan is not identified, the recommended plan will be the “no action” alternative. In most cases, the NER plan will be selected from among the best buy plans.

The following sections are outlined in accordance with report content guidance in ER 1105-2-100 and therefore do not follow exactly the planning steps as they occurred. Further, the planning process is iterative. As such, as additional information was learned in subsequent steps, it was necessary to revisit and repeat portions of the previous step(s).

ASSESSMENT OF PROBLEMS OPPORTUNITIES AND CONSTRAINTS

The Illinois River Basin has long been an important environmental and economic resource. This importance led Congress to recognize the Illinois River as part of the Upper Mississippi River System as a unique nationally significant ecosystem and a nationally significant commercial navigation system in Section 1103 of WRDA 1986. The National Research Council recognizes the Illinois River as a nationally significant floodplain river with excellent prospects for restoration.

The State of Illinois also recognizes the important resource that the Illinois River Basin represents. The Offices of the Governor and Lt. Governor have led efforts to focus attention on the Illinois River, including completing an *Integrated Management Plan for the Illinois River Watershed* and proposing “Illinois Rivers 2020”—a \$2.5 billion, 20-year State and Federal initiative to restore the Illinois River. Local groups within the river basin have been active in pursuing restoration. The State of Illinois has committed itself to restoration activities in the basin by leading planning efforts and enacting legislation aimed at basin restoration. The State has supported restoration efforts through the most successful Conservation Reserve Enhancement Program in the Nation and numerous locally led watershed planning initiatives. In addition, local groups strongly support and have been active in pursuing restoration in the basin.

a. Existing Conditions. The Pekin Lake Area is located adjacent to the city of Pekin and consists of six former and current bodies of water separated by moist soil plant communities and bottomland timber. Sediment deposited over the years has filled the

former lake basins, making most of these water areas dry or too shallow to sustain fish life during normal dry season/low water period pool levels in the Illinois River. The lakes and their former sizes were:

- Soldwedel Lake, 105 acres (old Pekin Lake)
- Worley Lake, 258 acres
- Lake of the Woods, 108 acres
- Slim Lake, 57 acres
- Round Lake, 16 acres
- Little Round Pond, 4 acres

These lake basin areas are all connected by channels, or culverts through man-made levees and causeways. The connecting channel to the Illinois River is located at the south end of Soldwedel Lake, near the Illinois Route 9 road bridge. The only water control structure at the site is a nonfunctioning, east-west levee that was constructed many years ago to retain water in Worley Lake, Upper Lake of the Woods, Round Pond, and Slim Lake for the purpose of waterfowl hunting. A causeway was constructed approximately 600 feet north of the levee to provide access and footings for a Central Illinois Light Company (CILCO) electric transmission towers and overhead lines. There are several culverts through the causeway, and the causeway does not function efficiently to retain water.

For many years, a low-level dam was maintained at the south end of Pekin Lake to retain water for ice cutting operations. Ice was cut from the lake and sold commercially. In 1938, the Peoria Lock and Dam were completed, replacing the dam at Copperas Creek. This resulted in a lower pool elevation in the Illinois River adjacent to Pekin Lake, thereby lowering water levels in Pekin Lake.

More recently, private duck clubs used Pekin Lake and the center levee was constructed to allow water control for waterfowl management. In 1965, CILCO purchased a 400-foot easement from the Pekin Rod and Gun Club and began construction of the power line causeway.

The Forest Park Foundation purchased the Pekin Lake property and sold it to the state in 1966. The land was purchased for open space, as a wildlife sanctuary, and to preserve the heron rookery. The state has since purchased other small tracts. Biological studies of the area have been conducted since 1962, including annual monitoring of the heron rookery.

Current management of Pekin Lake State Fish and Wildlife Area (SFWA) is passive. The dam at the south end of Pekin Lake has long since deteriorated and the center levee is no longer complete. During periods of high water, boats can enter Pekin Lake at the south end from the Illinois River. Other uses include bank fishing, hiking, picnicking, waterfowl hunting, archery deer hunting, and wildlife observation.

Hydraulics. The hydrologic conditions in the Pekin Lake project area are essentially determined by the Illinois River water level. River water enters the lakes

through a connection at the southern end of the site when river water surface elevations exceed the high-point elevation of 431 feet. It also enters the lakes via overland flood flow when it exceeds approximately 440 feet. Lick Creek once fed the lakes in this area, but at some point since 1904, the creek was channelized to flow directly into the Illinois River, and so very little area now contributes runoff directly to the lakes. Geotechnical investigations have confirmed that the lake bottom is composed of at least ten feet of clay material. It is therefore highly likely that the northern unit will hold water. Regional groundwater discharges into the Illinois River and the project area may intercept some of this groundwater flow. The other source of water to the site is direct precipitation.

The combination of the lack of upland runoff and the configuration of the outlet to the river has led to a lower sediment load to this area than experienced in many other backwater lakes. Sediment-bearing upland runoff is not a concern, and any groundwater or precipitation contributions would have little sediment. When water levels in the Illinois River are lower than approximately 440 feet, river inflows occur only through the constricted entrance at the south end of the site; river water would tend to back up through this constriction, reducing flow velocities and drawing water from the edge of the river instead of the high sediment-load flows in the main channel. When the river exceeds the bank-full level of approximately 440 feet, flood flows enter the site, contributing both sediment and water, and the effects of the constricted outlet no longer protect the site from sediment loading. It should be noted that the high-flow periods during which the river would have the most connection to the site are also the times of high sediment concentration, so despite the fact that the site is better off than some backwater lakes, it still receives a significant sediment load from the river.

Because the site is located between the Peoria Lock and Dam and the Kingston Mines gage on the Illinois River, it is possible to construct a hypothetical gage record of the water levels at the site outlet. Figure 2 shows the median annual hydrograph for 62 years of Illinois River water level records. Also shown are the 90% and 10% exceedance water levels, which correspond to the 10-year low- and high-water levels, respectively. This figure shows that the site is generally flooded from late March through late May, but that there is at least a 10% chance that it will be flooded on any day of the year except from late July until the autumn. The average annual high water level is 446.8 feet MSL, and the 90% and 10% exceedances are 442.7 and 452.1 feet MSL, so the site can be expected to flood even during the 10-year low-flow year. The corresponding low-water levels are 430.5, 429.8, and 431.2 feet MSL, so the site draws down nearly every year until the surface water connection to the river goes dry.

Although this water regime currently maintains the site, historic water levels may have been higher due to control of the Illinois River and changes on the site. The construction of Copperas Creek dam elevated river water levels at the site from the time it was constructed in the late 1870's until it was removed in 1936. The current dams at La Grange and Peoria maintain lower water levels in this area because the site is in the extreme upstream end of the La Grange pool and the effects of the dam are generally small relative to the effects of the Copperas Creek dam, which was only 16 miles downstream. The dam constructed across the outlet to benefit ice production in Pekin Lake, in combination with flows from an un-diverted Lick Creek and higher river water

levels, probably maintained higher water levels on the site at the turn of the 20th century. The dam across the outlet is non-existent, and the water regime is no longer affected by Lick Creek flows.

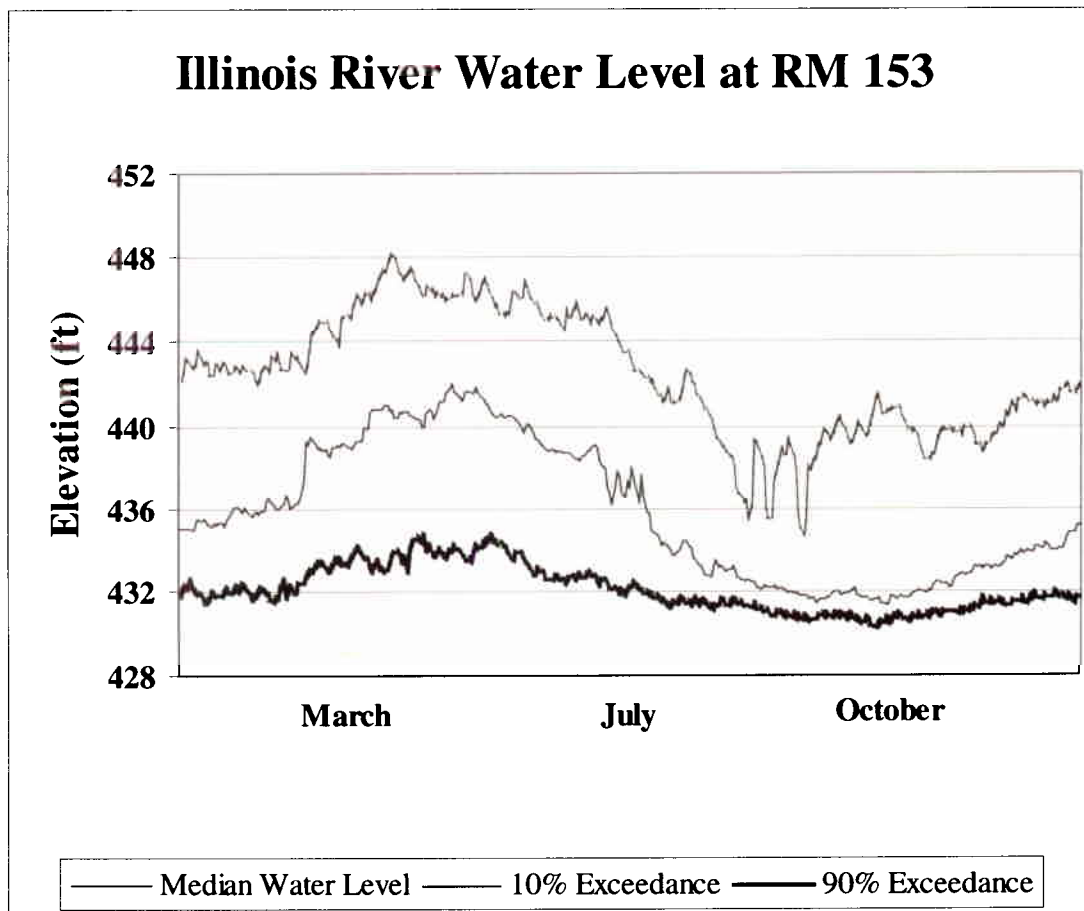


Figure 2. Median annual hydrograph for Illinois River Mile 153

Fishery Resources. Pekin Lake currently provides spawning and nursery habitat for Illinois River fishes. High river stages during spring provide fish access to off channel spawning sites. As spring floods subside, the fishes produced in Pekin Lake are drained back into the LaGrange Pool of the Illinois River. This recruitment of fish is a critical fishery function of the site and is essential to the aquatic health and vitality of the Illinois River. Any proposed water management structures at Pekin Lake should be designed in such a way that the fishery nursery function can be maintained.

Staff at the Illinois River Biological Station (IRBS) has been collecting fish data from the Pekin Lake complex since 1995. Boat access to Pekin Lake is limited throughout much of the year due to low water levels. However, 5,470 fish including 32 taxa have been collected using mainly fyke, minnow fyke, and electrofishing gears since 1995. The top five most abundant species collected over the period of record were gizzard shad (*Dorosoma cepedianum*), white bass (*Morone chrysops*), Common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*), and black bullhead (*Ameiurus melas*). In addition to fish, one common snapping turtle (*Chelydra serpentina*) and one red-

eared slider (*Chrysemys scripta*) were also collected at Pekin Lake. (Personal Com. Mark Pegg, INHS and LTRMP Website).

Forest Resources. Floodplain forests surrounding Pekin Lake occupy approximately 633 acres and consist of tree species typical of a seasonally flooded river bottom and cottonwood, silver maple, green ash, black willow, and boxelder constitute the most prevalent tree species at Pekin Lake. The hydrologic regime of the Illinois River has probably been the single largest factor in determining the forest condition at Pekin Lake, though historic logging, fire suppression, and disruption of other disturbance regimes have influenced forest structure.

The three soil types present are Jules silt loam, Lawson silt loam, and Landes fine sandy loam. These soils are listed in the *Soil Survey* as being frequently flooded, except Jules, which is listed as occasionally flooded. There is some likelihood that other bottomland hardwood species such as hackberry, pecan, pin oak, shingle oak, bur oak and black walnut may have occurred in this area (especially in the higher and drier sites) in the past but may have been eliminated by cutting and changes in hydrology.

Water depth is important not only for foraging habitat but also for maintaining the heron rookery trees. Prolonged annual floods are already causing tree mortality in the rookery. Therefore, water should never be deliberately held so high as to flood the bottomland forest at Pekin Lake, as this would increase the high water stress on rookery trees.

Waterfowl. In years of low river levels throughout the summer, the area provides very important pasture for Canada geese. This area also provides important brood habitat for mallards, wood duck, and Canada geese.

The area was opened to public waterfowl hunting in 1979. Currently, 12 blinds are allocated by an annual draw and hunted in compliance with statewide regulations. The blinds are located on Lower and Upper Lake of the Woods and on Slim Lake. The remaining areas of Pekin Lake (south of Lick Creek), including Lower Lake of the Woods, Soldwedel Lake, and Worley Lake, are managed as a refuge with no entry between 7 days prior to the opening of the regular waterfowl season through the close of the waterfowl season (including the late goose season).

Waterfowl usage of the site is recorded in periodic aerial inventory data collected by the Illinois State Water Survey. Inventories include information on numbers of individuals of various species of ducks and geese as well as some information on bald eagles and double-crested cormorants. Most flights were on a weekly basis when the weather permitted: fall (September-December): weekly 1949-1956, 1964-1966, 1971-2000 and spring (February-April): 1956, 1958, 1960, 1961, 1974, 1976-1985, 1987, 1990-2001.

Shorebirds. During low-water periods, large numbers of shorebirds feed in shallow water and exposed mud flats at Pekin Lake SFWA during their spring and especially fall migrations. Different species migrate at different times, but overall the spring migration is from mid-March through June, and the fall migration is from early

July through early November.

All shorebirds consume invertebrates, but different shorebird species prefer different foraging water depth and vegetation height and density conditions. A range of habitats is needed to support a diverse species assemblage. Variations in elevation at Pekin Lake allow a variety of foraging conditions at the same time. High shorebird use and high quality habitats led to an application to the American Bird Conservancy has been made nominating the area as a Nationally Important Bird Area.

Wading Birds. Large numbers of wading birds (herons, egrets, and night heron) nest and feed in the Pekin Lake area. This is consistently one of the largest rookeries on the Illinois River and has been active since at least 1935, except from 1973-1985 when logging caused rookery abandonment.

Wading birds forage in Pekin Lake throughout much of the year, except during floods or when the lake is frozen. These birds feed primarily on fish, but also on frogs, insects, crayfish, and small vertebrates. Great blue herons and great egrets require water depths between a few inches and 2 to 3 feet deep for foraging. Black-crowned night herons are smaller and forage in water less than 6 inches deep. High water not only eliminates foraging areas, but also results in dispersal of fish over a larger body of water, which compromises the quality of foraging habitat.

Each wading bird species has somewhat different timing, but in general, they arrive in February and March, lay eggs from March to June, and the nestlings develop and fledge between June and August. The most critical time to provide adequate water depths for these birds is during nesting and fledging.

Aquatic Vegetation. Staff at the Illinois River Biological Station (IRBS) began monitoring submerged aquatic vegetation within La Grange Reach of the Illinois River in 1991. The Pekin Lake area was not included in this sampling until 1998 when a stratified random sampling (SRS) design was implemented. Sampling within Pekin Lake has taken place yearly from 1998 through 2001. No submerged aquatic vegetation has been found within the Pekin Lake and surrounding area. Water depths taken during sampling varied depending on river stage from exposed mudflats to almost 13 feet. Substrate was dominated by silt and clay. Lack of submersed aquatic vegetation is probably due to a combination of biotic and abiotic factors, including water level fluctuation, increased sedimentation, and poor water quality, as well as uprooting and herbivory by fishes and waterfowl (Personal Com. Mark Pegg, INHS, and LTRMP website).

Invasive and Exotic Species. The main problems present are cockleburrs and willow invasion in some of the water areas such as Slim Slough. Reed canary grass is not much of a problem yet, but should be monitored closely. Purple loosestrife had not been found on the site as of the summer of 2000. However, it is found along the river just northwest of Pekin Lake, so it is only a matter of time before it occurs. The area should be monitored closely for purple loosestrife. All of the above species will

require monitoring and control measures, which will include drawdowns, flooding, disking, spraying, mowing, and herbicide.

Public Use. The site currently provides numerous recreational opportunities, including fishing, waterfowl hunting, bow hunting, picnicking, canoeing, small pleasure boating, hiking, and wildlife observation. Site use estimates included over 550 hunting trips during the 1999-2000 season, but this number is may likely significantly understate actual usage since the site is not staffed and sign-ins are voluntary.

Cultural. Initial investigations into cultural resource potential did not reveal any known historic sites and generally indicates low potential.

b. Future Without Project Conditions. Sedimentation has historically reduced and is likely to ~~continue to reduce the depth of backwater~~ lakes and side channels, deteriorating the natural aquatic resources. Even if relative equilibrium is being established in terms of sediment deposition, it remains very unlikely that the existing degraded habitats would see measurable improvements in the foreseeable future. Water level fluctuations associated with river regulation and human alteration are likely to continue to affect the site.

At Pekin Lake, the net result of changes in river management and historic sedimentation has been the shrinking of the historic Soldwedel Lake volume from an estimated 323 acre-feet in 1903 to 200 acre-feet in recent years (ISWS 2001). With respect to the expected future environmental condition of Pekin Lake, ongoing water level fluctuations and sedimentation will likely result in continued limitations or potential further decline in populations of fish and wildlife.

In preparation for the Habitat analysis, a baseline without project condition was developed for the northern and southern units of the project area. These serve as the base conditions from which to measures benefits of various project alternatives. They are also useful in putting a number against our anticipated future without project condition.

In the Northern Unit, the management goals are to maximize and improve reliability of moist soil plant production areas, our cover types are deep water, shallow water, moist soil/emergent, scrub shrub, and forested. Over the 50-year life of the project, if nothing is done, we will see significant losses (approximately 30%) of our moist soil and emergent cover types necessary for healthy moist soil plant production. Further, the shallow water feeding areas that support the Heron rookery will decline by approximately 40%. Finally, the scrub-shrub and forested areas will grow in proportion to the losses ~~seen for moist soil/emergent and shallow water~~. The ~~northern~~ unit is already predominately forested and the willow dominated scrub-shrub cover types have marginal habitat value in relation to what is being lost in moist soil plant production.

Table 3-? Northern Unit Without Project Conditions

Northern Unit Baseline Habitat Conditions		Without Project				
		Target Year				
<i>Cover Types</i>	<u>Description</u>	0	1	5	20	50
<i>Deep</i>	Deep water = or > 4ft in depth	0.0	0.0	0.0	0.0	0.0 acres
<i>Shallow</i>	Shallow open water	31.7	31.4	30.1	25.9	18.4 acres
<i>Moist/Emergent</i>	Combination of moist soil, mud flat, and emergent cover types	202.3	200.6	193.8	170.9	128.9 acres
<i>Scrub-Shrub</i>	Scrub Shrub areas that are invading the Moist Emergent areas, predominantly willows.	114.1	115.0	118.4	129.0	141.1 acres
<i>Forested</i>	Forested areas, including forested wetland and bottomland hardwood	304.8	305.9	310.5	327.1	364.5 acres
		652.90	652.90	652.90	652.90	652.90 acres

In the Southern Unit of Pekin Lake, the management goals are to increase overwintering habitat for fish. Currently, no overwintering habitat exists on the site and is limited in the Illinois River. Over the 50-year life of the project, if nothing is done, we will see significant losses (approximately 43%) of the remaining shallow water in the Southern unit. The moist soil/emergent cover will also decline, giving way to additional scrub-shrub willow invasion and marginal quality forested areas.

Table 3-? Southern Unit Without Project Conditions

Southern Unit Baseline Habitat Conditions		Without Project				
		Target Year				
<i>Cover Types</i>	Description	0	1	5	20	50
<i>Deep</i>	Deep water = or > 4ft in depth	0.0	0.0	0.0	0.0	0.0 acres
<i>Shallow</i>	Shallow open water	41.6	41.2	39.5	34.0	24.1 acres
<i>Moist/Emergent</i>	Combination of moist soil, mud flat, and emergent cover types	208.6	206.9	200.3	177.8	136.1 acres
<i>Scrub-Shrub</i>	Scrub-Shrub Areas that are invading the Moist Emergent areas, predominately willows	91.3	92.5	97.1	111.5	130.7 acres
<i>Forested</i>	Forested areas, Including Forested Wetland and Bottomland Hardwood	105.7	106.6	110.3	123.9	156.2 acres
		447.20	447.20	447.20	447.20	447.20 acres

c. Problems and Opportunities. The principal problems at Pekin Lake are altered hydrologic regimes and the lack of depth diversity, resulting in reduced habitat value and diversity. Backwater lakes and side channels along the Illinois River formerly provided a great variety of high quality habitat types with greater depth diversity. These areas formerly provided large areas of deep and shallow water habitats and numerous sloughs and forested wetland habitats. Pekin Lake, which has a relatively low sedimentation rate compared to many other Illinois backwaters, provides an excellent opportunity for restoration of many of these habitat types.

Opportunities listed below were used as the foundation for the development of alternatives to address the principal problems at Pekin Lake:

- Preserve and maintain the existing natural heritage and wildlife resource integrity of the site with emphasis on waterfowl management, protect the heron rookery and other sensitive avian species, and maintain the site's value as a fish nursery to the La Grange Pool of the Illinois River.
- Restore habitats and species lost from much of the Illinois River Valley, including overwintering off-channel habitat for fish, aquatic plants, mast trees, and invertebrates.
- Maintain and improve the site's connectivity with the river.
- Provide public recreational activities that are consistent with the major objectives of improved aquatic habitat, enhanced wetland function, and improved terrestrial habitats. Further recreation should detract from the area's natural value, including consumptive fish and wildlife programs, picnicking, canoeing, small pleasure boating, hiking, and wildlife observation, and provide for scientific research and educational studies at the site. Federal involvement in recreation features is limited to 10% of the overall project costs, and the features cannot diminish the restoration efforts.

In consultation with the non-federal sponsor and interested parties from the City of Pekin, Goals and Objectives were developed during the summer of 2001 and finalized at a meeting on December 6, 2001. They are the following:

Project Goals, Objectives, and Potential Enhancement Features

Goal	Objective	Feature (proposed)
<i>Improve aquatic habitat</i>	Provide overwintering fish habitat	Dredge connection with main channel Dredge areas of >6ft depth
	Improve spawning and nursery habitat	Dredge areas of ~4ft depth over firm substrate Add structure – rock/woody debris
	Improve water quality – (ammonia and DO)	Maintain flow or some aeration through – siphon, pipeline from Peoria pool, or bubbler.
<i>Enhance wetlands</i>	Improve migratory waterfowl and shorebird habitat	Establish a waterbird management area (improve moist soil plant production)
	Maintain and enhance heron feeding areas	Establish a waterbird management area (depths 2-3 feet and less)
	Increase the diversity and extent of aquatic vegetation	Decrease rapid water level fluctuation (lower and upper management areas)
		Place a closing structure on the lower end of the site.
<i>Improve terrestrial habitat</i>	Protect heron and egret rookery	Manage water levels to avoid impacts to rookery trees

		Develop future rookery sites
	Improve forest diversity and introduce mast trees	Use dredge material to create areas of higher elevation.
		Forest management and tree planting

PLANNING CONSTRAINTS

The principal focus of this study is to identify opportunities for restoring degraded ecosystem structures and functions, including the ecosystem's hydrology, plant, fish, and wildlife communities, to a less degraded condition. Several constraints must be taken into account in developing alternatives to achieve the above focus.

- **Constraint #1** - Avoid adverse impacts to the existing heron rookery. Minimize flooding in the heron rookery. Prohibit activity on or near the rookery from February through August to avoid disturbing nesting birds. Minimize disturbance to foraging wading birds, especially from February through August. Monitor the heron rookery annually.
- **Constraint #2** - Avoid adverse impacts to the existing eagle nest, located along the Illinois River bankline at approximately river mile 153.3. Activity within 330 feet of the eagle nest should be prohibited from January 1 to August 31. If necessary, signs can be posted to designate the restricted area.
- **Constraint #3** - Avoid impacts to *Boltonia decurrens* (decurrent false aster), a state and federally threatened plant that grows in several locations at Pekin Lake SFWA. Excessively high water should not be held deliberately in the north end of Pekin Lake SFWA (Worley Lake) during the summer and fall.
- **Constraint #4** - Any proposals that would involve modifications or potential effects on the CILCO power company central road will require coordination and CILCO agreement.
- **Constraint #5** - The powerline that crosses the site has the potential to adversely affect migratory waterfowl.
- **Constraint #6** – Dredged material placement in the floodplain cannot significantly increase flood heights.
- **Constraint #7** – Any proposals that involve the use of stormwater culverts under the railroad and Illinois Rt. 29 will require coordination and Railroad and Illinois Department of Transportation (IDOT) agreement.
- **Constraint #8** – The quarry site proposed for dredge material placement is in private ownership, therefore cooperation by the landowner is required for this option to become feasible.

ALTERNATIVE PLANS

Before alternative plans were formulated, the first step was to identify general locations and categories of potential improvements that would satisfy the goals and objectives established previously. During the study process and review of existing conditions, studies and activities, it became clear that the northern and southern units of the Pekin Lake area are quite distinct in their ecosystem function. Certain habitat types are common to both, such as bottomland forest and shallow water. However, the northern unit is unique in its preponderance of productive moist soil plant habitat and the southern unit remaining shallow water and direct access to the navigation channel. Therefore, potential alternatives to be developed were done so in a manner that addresses the unique characteristics of the northern and southern units of Pekin Lake.

The process of developing final alternative plans occurred over ten months, from June 2001 through April 2002. A Regional Team consisting of IDNR site managers, regional biologists, City of Pekin representatives, and Corps personnel, met monthly to formulate these alternatives. The process began with several discussions concerning the management goals and objectives in practice by the State of Illinois. This yielded an array of *general measures* from which *specific measures* were developed. The formulation of these specific measures involved an assessment of the measures as to whether they met the goals and objectives of the study and how likely they were to produce measurable habitat benefits. Obviously, this is a subjective process requiring trade off analysis and habitat evaluation procedures; however, the depth of professional experience and first-hand management knowledge by many members of the team was invaluable.

During this process, several specific measures were screened for a variety of reasons. They are not included as specific measures but are described in the screening section below, along with necessary justification for their elimination from consideration. Upon finalization of specific measures, alternatives were developed through combination of specific measures. This development of *combined alternatives* is described below.

General Measures. As each potential category of measures was developed, a corresponding list of criteria related to each potential measure was developed. As the site is actively managed by IDNR field staff, their expertise played a key role in development of the criteria. Further, IDNR has developed a management plan for the site that was used to guide criteria development and assist with development of specific measures. Below are listed the potential categories of actions, and corresponding criteria, to provide improved aquatic habitat, water level management, and improved terrestrial habitat.

- a. **Dredging and sediment removal to create aquatic habitat (Southern Unit).** The reconnaissance study, 905(b) analysis, discussed the potential for dredging to improve aquatic habitat diversity and function. The filling that has occurred has eliminated the conditions necessary for aquatic plant communities. Further, the lack of depth, diversity, and aquatic structure in the southern unit, has severely limited deep-water area for fisheries. This

category of measures would involve dredging portions of Soldwedel Lake and Lake of the Woods to a depth consistent with healthy aquatic ecosystem function at this location. Variations include channel connections between the lakes, large and small area dredging, finger-like channels off main dredge areas, deep potholes, deep and shallow dredging. Criteria include:

- Provide adequate deep-water connection with the main channel of the Illinois River.
- Provide overwintering fish habitat – areas with greater than 6-8 feet in depth. Assuming 90% exceedence of EL. 432.0 msl (Mean Sea Level) water surface elevation during winter months. Deep dredging is 6 feet + 2 feet of sedimentation over a 50-year project life = 8 feet. $432.0 - 8.0 = \text{EL. } 424$. At the beginning of the project life, there will be a 10% chance in any given year that fish will have less than 8 feet of water during the winter. Holes are assumed to be 4 feet deeper than channels and fingers (EL. 420.0).
- Provide spawning, nursery habitat for fish areas with 4 feet of depth. Shallow dredging is assumed to be 4 feet more shallow than deep dredging, or EL. 428.0.
- Project measures should be sustainable through the project life and minimize any increase in additional sedimentation.
- Historic sedimentation rate for Soldwedel Lake is 0.3 inches per year (See Geotechnical Appendices ?-?).
- Provide foraging areas for great blue heron and egret that are up to 2 feet deep.
- Avoid dredging any areas with elevations 433 or greater to minimize losses to moist soil plant communities already present.

b. Dredged material placement (Southern Unit). Any discussion of dredging backwater areas necessitates development of dredge disposal options. This category would include several onsite placement alternatives, one adjacent placement site proposed by the City of Pekin, and several off-site placement alternatives. Onsite alternatives can include use of material for levee construction, terrestrial habitat creation, and placement on agricultural fields. The nearby site option includes disposal in an abandoned gravel pit adjacent to the site. Off-site disposal may include transport to Chicago for use as cover for formerly used industrial sites. Criteria include:

- Minimize impacts to existing moist soil plant communities (i.e. areas approximately 433.0 to 437.0 elevation)
- If placement is in the Pekin Lake complex, shoreline areas are preferable to increase habitat diversity.
- Use material, if feasible, to increase elevations allowing for improved forest diversity and reintroduction of mast trees.
- Consider options than utilize geotubes to contain dredged materials.
- Avoid wetland mitigation site at former agricultural field area.

- c. **Access channels (Southern Unit).** Currently, the main connection between the Illinois River to Pekin Lake is at the south end of Pekin Lake. The channel allows for fish and boat access to the Lake during periods of high water. The primary purpose of investigation into this category of options is to allow for dredge equipment to enter into Soldwedel and Lake of the Woods. Ancillary benefits would be for boat access. Finally, this measures will allow for fish access during low water periods. Criteria include:
- Prevent displacement of Pekin Boat Club facilities.
 - Provide for the shortest distance of access(cost) and adequate access for dredge equipment.
 - Provide access to the Illinois River for fish during low-water periods.
- d. **Cross levees for water level management (Northern Unit).** The reconnaissance study, 905(b) analysis, discussed the potential for water level management in the northern portion of Pekin Lake for aquatic plant production and enhanced management of moist soil units in the area. This category of measures includes construction of new levees at various locations, repair and reinforcement of the existing breached IL IDNR levee, repair and reinforcement of existing Central Illinois Light Company (CILCO) causeway. Criteria include:

Biological

- Desired management of water levels in the upper unit is approximately 70 days summer drawdown (July 1 – Oct 15) to 435.5 feet msl (mean sea level) for aquatic plant production, gradual water level raise (Sept – Oct) to 437 feet msl; hold until spring for waterfowl.
- Reduce fluctuation. 2-3 days of inundation will kill moist soil plants.
- Provide foraging areas for great blue heron and egret up to 2 feet of depth.
- Trees generally survive if water levels throughout most of the year are 1-2 feet below root level.
- The desired water level management must protect the existing heron rookery trees.
- Future with-project conditions should support more diverse forest and new stands of mast trees.

Engineering/Site

- Cross levee height should match the natural river side levee elevation (approximately EL. 443) with spillway elevation at 441.
- Levees should have 3 feet of freeboard for safety.
- At high river stages (approximately El.440 feet or above) it is not desirable to manage northern unit by lowering water level elevations below river levels.

- At low river stages (<433) it is desirable to maintain and manage northern unit at higher elevations (435-437) and reduce fluctuations (design to maintain 438).
- Design for potential complete drawdowns without the use of mechanical means.
- Geotechnical investigation must be conducted to determine if any groundwater connection with the river will eliminate plans to manage water levels in the northern unit.

e. Water inflow structures for water level management (Northern Unit).

Successful water level management in the northern unit would benefit from a reliable source of water to maintain the desired water levels for aquatic plant production. This category includes pipeline options using Peoria Lock and Dam as a source, pumping stations from the Illinois River, groundwater well and pumps, and a closing structure or gate to trap natural high flows in the northern unit. Consideration was given to a pipeline from Peoria Lock and Dam, pump station, and a well. Criteria include:

- Desired filling time is ?????
- Design for potential complete drawdowns without the use of mechanical means.
- Design for minimal operations and maintenance requirements.
- Mechanical pumps have reliability and noise issues.
- Minimize disturbance to existing resources.
- Avoid heron rookery area.
- Pipeline should be buried for protection against UV light that would decay plastic pipe, vandalism, barrier to human and animal movement, freezing, and movement and damage during high water.

f. Rehabilitation and Sculpting (Northern Unit). Slim Lake and other areas within the complex are currently in the stages of transitions from aquatic to terrestrial habitat. Willows and other lower quality **terrestrial species** are beginning to emerge. Options were explored to improve the viability of the shallow water aquatic habitat currently being lost. Part of the water level management goal that has been established is the desire, by the IL IDNR, to be able to draw down the water level of the northern unit. The benefits would include sediment compaction, moist soil plant production, and shorebird feeding areas. Therefore, some degree of sculpting is required so that as a draw down occurs, the drainage of water will be complete throughout the northern unit and result in no ponding of water. In other backwater areas of the Illinois River Valley, cases of botchalism have occurred when poorly drained backwaters result in large fish kills. Criteria include:

- Reconfigure Slim Lake to delay woody vegetation from becoming **established**. **Approximately one additional foot of depth** will be required.

- Management objective is to completely de-water Worley Lake.
 - Break up of wind fetch.
- g. Recreation.** Currently the site is open to the public and recreation is passively managed. The opportunity exists to enhance recreational opportunities at the site without diminishing ecosystem benefits. This category includes additional public access points and parking, public boat access, piers, and walking trails. Criteria include:
- Federal involvement in recreation features is limited to 10% of the overall project costs and the features cannot diminish restoration efforts. The cost share is 50/50.
- h. Aquatic Structures (Southern Unit).** The goal of improving aquatic habitat through non-dredging alternatives is necessary to provide for a full and complete range of alternatives. This category includes rock structures (reefs, jetties, etc.) and woody debris. Criteria include:
- Increase aquatic habitats.
- i. Lower end water control structures (Southern Unit).** Water level management in the southern unit for the enhancement of moist soil plants was identified as part of the larger water level management and improved habitat goals. This category includes installation of a control structure at the southern end of Soldwedel and Lake of the Woods. This structure would allow for the creation and management of a pool in the lower unit. Criteria include:
- Reduce water level fluctuations in summer moist soil plant growing season.
 - Ability to remove gate(s) for lowering of water levels during the majority of the year to maintain connectivity.
 - Allow for boat passage.

Specific Measures. Reflecting the criteria outlined above and the constraints present at the project site, specific measures were developed within the broad categories of potential measures. These measures are intended to satisfy the objectives and reach the goals of the project study.

a. Dredging and Sediment Removal Measures. (See Plates D1-D7)

- **D1 15.3 Acres of Dredging: Connecting Channels (Base Option)** – 50' wide channel from the river into Soldwedel Lake, and 50' wide channel from Soldwedel Lake into Lake of the Woods to EL. 424.0 +/- . This option is included in all other dredging measures.

- **D2 22.8 Acres of Dredging: Connecting Channels with Finger Channels and Holes** – Dredge finger channels to EL. 424.0+/- and holes to EL. 420.0+/- in both Soldwedel Lake and Lake of the Woods.
- **D3 37 Acres of Dredging: Shallow Dredge 25% of Lower Lakes** – This measure includes D2 plus dredging 25% of both lower lakes to EL. 428.0' +/- with finger channels to EL. 424.0' +/- and holes to EL. 420.0' +/-.
- **D4 43.4 Acres of Dredging: Combination of Deep and Shallow Dredging 25% of Lower Lakes** – Dredge a main channel and shallow dredge to 428.0' +/- and 424.0' (channel) +/- . Deep dredge to 420' +/- with total dredge area not to exceed 25% of the lower lakes.
- **D5 Shallow Dredge 50% of Lower Lakes** – This measure includes D2 plus dredging 50% of lower lakes to EL. 428.0' +/- with finger channels to EL. 424.0' +/- and holes to EL 420.0' +/-.
- **D6 Shallow Dredge 100% of Lower Lakes** – This measure includes D2 plus dredging 100 % of the lower lakes to EL. 428.0' +/- with finger channels to EL. 424.0' +/- and holes to EL. 420.0' +/-.
- **D7 Deep Dredge 50% of Lower Lakes** – Dredge 50% of the lower lakes to EL. 424.0 +/-.

b. Dredge Material Placement. (See Plates L1-L4, P2-P7, P9, P10)

- **P1 Cross-levee Options** – Place material and a control structure to establish or raise existing structure to assist in water level management. These measure include a control structure for water level management. Spillway elevation will be at 441.
 - **L1 Reinforce/Raise and Modify CILCO Causeway** – Add material on top of and on CILCO causeway
 - **L2 Reinforce/Raise Existing IDNR Levee** – Add material to and raise existing IDNR levee.
 - **L3 Construct New Levee Upstream of CILCO Causeway** – New levee alignment upstream of CILCO causeway.
 - **L4 Construct New Levee Downstream of CILCO Causeway** – New levee alignment between CILCO causeway and IDNR levee.
- **P2 Raise Low Elevation Swale on Natural Levee** - Raise low spots to EL. 443.0' +/- from the west end of any cross levee option, upstream along bankline. EL. 440.0' is the existing low swale elevation. Material would be used to raise this one location to EL. 443.0'
- **P3 East Side of Soldwedel Lake** – Placement would occur adjacent to and parallel to the railroad embankment to serve as a buffer between the railroad, residential areas and the lake. The potential is for this area to be used for continued road access, parking, and boat ramps. Finally, placement at this location would increase shoreline length, diversity of transition habitat, and areas for mast tree production.

- **P4** *West Side of Lake of the Woods* – Place material along the west side of Lake of the woods. The material would be placed high enough to allow for the production of mast trees.
- **P5** *Between CILCO Causeway and IDNR Levee* – Fill in an area between the two features to an elevation high enough to support mast tree production or stockpile material along one of the levee alternatives
- **P6** *City of Pekin Quarry Site* – Hydraulically pump material under railroad and IL Rt. 29 to an abandoned quarry site on the east side of Rt. 29.
- **P7** *Former Agricultural Lands Upstream & Downstream of Lick Creek* – Hydraulically pump material for placement on abandoned agricultural fields.
- **P8** *Removal Offsite* – Ship material by barge or rail to Chicago Superfund sites, Banner Marsh or Rice Lake.
- **P9** *Create Islands in Lower Lakes* – Mechanically or hydraulically dredge material and create islands to the side of finger channels and/or holes.
- **P10** *Fill Geotubes in Worley Lake* – Fill geotubes and orientate perpendicular to prevailing wind direction to reduce wind fetch and wave action in Worley Lake.

c. Access Channel To Pekin Lake. Originally, three potential access points could be explored. However, after preliminary site visits it was realized that one option was preferred that required no additional lands outside of IDNR ownership and it provided the most direct route at the lowest cost. Therefore, all dredge option includes access from the Illinois River at this location. This access route is shown on any of Plate D1-7.

d. Water Inflow Structures. (Plates W1-W4, W6, W7)

- **W1** *East Side Railroad Pipeline* – Run a pipeline from the southeast bank of the Illinois River above Peoria Lock and Dam along the rail road corridor to Worley Lake.
- **W2** *West Side Railroad Pipeline* – Run a pipeline from the northwest bank of the Illinois River above Peoria Lock and Dam along the rail road corridor to Worley Lake.
- **W3** *East Side Riverbank Pipeline* – Run a pipeline from the southeast bank of the Illinois River above Peoria Lock and Dam along the riverbank to Slim Lake.
- **W4** *West Side Riverbank Pipeline* – Run a pipeline from the northwest bank of the Illinois River above Peoria Lock and Dam along the riverbank to Slim Lake.
- **W5** *Natural Hydraulics* – Allow high water to fill Worley and Slim Lakes then close a structure (P1 Measures) so that high water level is maintained. The potential for filling to desired elevation (EL. 438.0 +/-) under natural conditions is 1 in 3 years.

- **W6 Pump Station** – Install a pump station near the Illinois River bankline adjacent to Worley and Slim Lake.
- **W7 Well with Pump** – Construct a groundwater well and pump on site.

e. Rehabilitation and Sculpting. (See Plate M1 & M2)

- **M1 Rehabilitate Slim Lake** – Taking care to avoid the heron rookery, remove willows and shallow dredge Slim Lake. Dredge depths would be to EL. 436.0' +/- . Material would be disposed of on any of the P1 alternatives.
- **M2 Sculpting for Drainage** – Sculpting of upper unit submerged contours to allow for complete drainage of upper unit to eliminate ponding during drawdowns to approximate EL. 430.0 +/- . Drawdowns will occur when conditions, determined by the site manager, for the outbreak of botchellism are present.

f. Recreation. (See Plates ? - ?)

- **R1 Public Access & Parking** – If dredge placement site P3 is included in the recommended plan, public access and parking facilities would be located here. The IDNR currently maintains an access road, limited parking, and a small picnic area at this location. This measure would include improvements and expansion of existing facilities.
- **R2 Public Boat Ramp** – This measure includes construction of a public boat access ramp on the east bankline of Soldwedel Lake.
- **R3 Fishing Pier** – This measure includes construction of a public fishing pier on the east bankline of Soldwedel Lake.
- **R4 Trails** - If dredge placement on the East bankline is included in the recommended plan, portions of walking trails would be located here. This measure includes walking trails along the east bankline of Soldwedel Lake and possibly along any of the cross levee measures.

g. Aquatic Structures. Originally, it was thought that aquatic structures could be added to enhance edge habitat diversity. However, after input from site managers, review of existing conditions, formulation of dredge and sediment removal measures and inclusion of dredge material placement measure P9, it was concluded that additional aquatic structures would be redundant and add to total project cost. Therefore, they were no longer considered as part of the study.

h. Lower end Water Control Structures. This category of potential measures was eliminated due to excessive cost and unsuitability with more fully defined management objects by the non-Federal Sponsor. In particular, the desire to restore deep water habitats in the Southern Unit and water level management for moist soil plants in the Northern Unit. Therefore this category of measures was no longer considered as part of the study.

Table 3-? Preliminary Specific Measures

Category	Specific Measure	Symbol	Affected Unit	Study Goal
<i>Dredging and Sediment Removal Measures</i>	15.3 Acres of Dredging: Connecting Channels (Base Option)	D1	Southern	Improve Aquatic Habitat
	22.8 Acres of Dredging: Connecting Channels with Finger Channels and Holes	D2		
	37.0 Acres of Dredging: Shallow Dredge 25% of Lower Lakes + D2	D3		
	43.4 Acres of Dredging: Combination of Deep and Shallow Dredging 25% of Lower Lakes	D4		
	Shallow Dredge 50% of Lower Lakes + D2	D5		
	Shallow Dredge 100% of Lower Lakes + D2	D6		
	Deep Dredge 50% of Lower Lakes	D7		
<i>Dredged Material Placement</i>	Cross-levee Options Reinforce/Raise and Modify CILCO Causeway	P1 P1L1	Southern	Improve Aquatic Habitat
	Reinforce/Raise Existing IDNR Levee	P1L2		Enhance Wetlands
	Construct New Levee Upstream of CILCO Causeway	P1L3		Improve Terrestrial Habitat
	Construct New Levee Downstream of CILCO Causeway	P1L4		
	Raise Low Elevation Swale on Natural Levee	P2		
	East Side of Soldwedel Lake	P3		
	West Side of Lake of the Woods	P4		
	Between CILCO Causeway and IDNR Levee	P5		

	City of Pekin Quarry Site	P6		
	Former Agricultural Lands Upstream & Downstream of Lick Removal Offsite	P7		
	Create Islands in Lower Lakes	P8		
	Fill Geotubes in Worley Lake	P9		
		P10		
<i>Water Inflow Structures</i>	East Side Rail Road Pipeline	W1	Northern	Improve Aquatic Habitat
	West Side Rail Road Pipeline	W2		
	East Side Riverbank Pipeline	W3		Improve Water Level Management
	West Side Riverbank Pipeline	W4		
	Natural Hydraulics Pump Station	W5		
	Pump & Well	W6		
		W7		
<i>Rehabilitation and Sculpting</i>	Rehabilitate Slim Lake	M1	Northern	Improve Aquatic Habitat
	Sculpting for Drainage	M2		
<i>Recreation</i>	Public Access & Parking	R1	Northern & Southern	
	Public Boat Ramp	R2		
	Fishing Pier	R3		
	Trails	R4		

Initial Screening of Specific Measures. Typically screening does not occur until alternative plans are developed. However, due to the compressed implementation schedule for the study, iterative formulation of goals and objectives concurrent with development of measures and lessons learned through previous cooperative study efforts with the State of Illinois IDNR, efficiencies in study execution were gained through preliminary screening of specific measures. Reasons for elimination of specific measures include excessive construction costs before real estate appraisals are made, inconsistency with goals or objectives, and inability to acquire land, easements, rights-of-way, relocation, and disposal (LERRD) areas. Table 3-? details which alternatives were eliminated from further consideration and why.

Table 3-? Specific Measures Screened from Further Consideration

Category	Specific Measure	Symbol	Justification for Elimination from Further Consideration
<i>Dredging and Sediment Removal Measures</i>	Shallow Dredge 50% of Lower Lakes + D2	D5	Initial Cost Estimates, not including Real Estate, was \$8,502,220. The Federal per project limit of this authority is \$5 million.
	Shallow Dredge 100% of Lower Lakes +D2	D6	Initial Cost Estimates, not including Real Estate, was \$11,730,410. The Federal per project limit of this authority is \$5 million.
	Deep Dredge 50% of Lower Lakes	D7	Initial Cost Estimates, not including Real Estate, was \$9,442,850. The Federal per project limit of this authority is \$5 million.
<i>Dredge Material Placement</i>	Reinforce/Raise Existing IDNR Levee	P1L2	Measure P1L1 is supported by CILCO and is the lowest cost option of the P1 Cross-levee Options.
	Construct New Levee Upstream of CILCO Causeway	P1L3	Measure P1L1 is supported by CILCO and is the lowest cost option of the P1 Cross-levee Options.
	Construct New Levee Downstream of CILCO Causeway	P1L4	Measure P1L1 is supported by CILCO and is the lowest cost option of the P1 Cross-levee Options.
	Between CILCO Causeway and IDNR Levee	P5	Placement of material at this location would negatively impact vegetation that site managers felt was critical to the sites health. Therefore, it is inconsistent with the study goal of improving terrestrial habitats.
	Former Agricultural Lands Upstream & Downstream of Lick	P7	The distance from the dredging locations will require multiple booster pumps to move the material at a cost the non-federal sponsor would not support. Further, a wetland mitigation site exists in this location and would have to be avoided.
	Removal Offsite	P8	A barge transport option was investigated and cost estimates ranged from \$5,337,500 to \$9,912,500 depending on who initially fills the barges. The Federal per project limit of this authority is \$5 million.
	Fill Geotubes in Worley Lake	P10	Placement of Geotubes in Worley Lake would negatively impact moist soil habitats being managed. Therefore, the measure is inconsistent with the study goal of improving aquatic and terrestrial habitats. Additionally the costs were considered excessive.

<i>Water Inflow Structures</i>	Pipeline	W1, W2, W3, W4	Initial lowest cost estimates for these measures were \$1,1281,500. Measure W7, Pump & Well, was estimated at \$383,655. These measures provide the same function. Therefore, W7 was chosen as the preferred measure for delivery of water to the northern unit. Lifecycle costs are included in the estimate.
	Pump Station	W6	Initial cost estimates for this measure was \$2,022870. Measure W7, Pump & Well, was estimated at \$383,655. These measures provide the same function. Therefore, W7 was chosen as the preferred measure for delivery of water to the northern unit. Lifecycle costs are included in the estimate.

At the request of the non-Federal sponsor, Specific Measure P8 – Removal Offsite, was further investigated for cost of dredging, transport and offloading at the Banner Marsh site. Rock Island District Cost Engineering estimated a Cubic Yard Cost at \$21 (Personal communication with Mike Cox OD-T. The \$21/CY is broken down as follows:

\$ 10/CY - Mechanical Dredging and transport first 4 miles

\$ 1.40/CY additional - Transport 4-8 miles

\$ 1.70/CY additional - Transport greater than 8 miles

\$7.80/CY additional - Pump out dredged material from barge to disposal site

The smallest dredge option, proposes to remove 291,573 CY of material from the southern unit. The estimated cost at \$21/Cy is \$6,123,033. A total cost estimate of \$8,181,179 includes contingency (25%), EDC, S&A, and As-Builts.

Selection and Combination of Measures into Alternatives. In keeping with the desire to manage the northern and southern units for different habitat types, alternatives were developed that combined the various remaining specific measures to provide the maximum range of alternatives. Based on discussions with the sponsor and a study team review of goals and objectives, these alternatives are supported and suitable for evaluation and comparison analysis.

a. Alternatives Plans for Southern Unit. The goals for the southern unit are to improve aquatic and terrestrial habitats through restoration that provides overwintering fish habitat, spawning and nursery areas for fish, improved water quality, and improved forest diversity through mast producing trees. Dredging and sediment removal measures were matched with the range of placement measures. The range of dredge placement options were merged into three general features, onsite placement, a combination of on and offsite placement, and all offsite. This was done to reflect the quantities of dredge

material produced by the specific dredging measures. Each specific dredge placement measure is unable to accommodate the entire material disposal requirements of any dredge option. In addition, alternative S1 does not produce sufficient material for island construction. Finally, alternatives S5 and S6 add the possibility of disposal at the quarry sites. The total quantity of material to be disposed of is the same as alternative S3 and S4. The material sent to the quarry would come from the bankline placement areas adjacent to Soldwedel Lake. The alternatives below also represent a full range of alternatives that provide for both on and offsite placement of dredge material. The alternatives are:

S0 No Action Alternative

S1 15.3 Acres of Dredging with Onsite Placement (Base Option). Plate S-1 This alternative involves dredging deep channels into Soldwedel and Lake of the Woods. Placement of material would be on the bank to the east of Soldwedel Lake and west of Lake of the Woods.

S2 22.8 Acres of Dredging with Onsite Placement Plate S-2. This alternative involves dredging deep channels, finger extensions, and deep holes into Soldwedel and Lake of the Woods. Placement of material would be on the bank east of Soldwedel Lake and west of Lake of the Woods, and into small geotube islands.

S3 37.0 Acres of Dredging with Onsite Placement. Plate S-3 This alternative involves dredging deep channels, finger extensions, and deep holes into Soldwedel and Lake of the Woods. Further shallow dredging of approximately 25% of the two lower lakes would occur. Placement of material would be on the bank east of Soldwedel Lake and west of Lake of the Woods, and into small geotube islands.

S4 43.4 Acres of Dredging Onsite Placement. Plate S-4. This alternative involves dredging deep channels into Soldwedel and Lake of the Woods. Further shallow and deep dredging of approximately 25% of the two lower lakes would occur. Placement of material would be on the bank east of Soldwedel Lake and west of Lake of the Woods, and into small geotube islands.

S5 37.0 Acres of Dredging with On and Offsite Placement. Plate S-5. This alternative is the same as Alternative Plan S3 but adds a measure of offsite placement at the offsite quarry.

S6 43.4 Acres of Dredging with On and Offsite Placement. Plate S-6. This alternative is the same as Alternative Plan S4 but adds a measure of offsite placement at the offsite quarry.

S7 37.0 Acres of Dredging with Offsite Placement. Plate S-7 This alternative involves dredging deep channels, finger extensions, and deep holes into Soldwedel and Lake of the Woods. Further shallow dredging of approximately 25% of the

two lower lakes would occur. This plan is the same as S-3, except, placement of the material would be at the quarry site across Illinois Rt. 29.

S8 43.4 Acres of Dredging with Offsite Placement. Plate S-8 This alternative involves dredging deep channels into Soldwedel and Lake of the Woods. Further shallow and deep dredging of approximately 25% of the two lower lakes would occur. This plan is the same as S-4 except, placement of the material would be at the quarry site across Illinois Rt. 29.

After initial completion of the HEP and Cost Analysis, the Sponsor requested that alternatives that incorporated Specific Measures D5 (Shallow Dredging 50% of the Lower Lake and D6 (Shallow Dredging 100% of the Lower Lake) be formulated into alternative plans with placement option. The sponsor is interested in fully understanding the cost and benefits of these options for two reasons. First, the additional increment of cost of these two alternatives is something the sponsor may be willing to pay for. Second, the Quarry site owners (P6) have expressed an interest in purchasing the additional material generated by these options for use in filling the quarry.

S9 Enhanced Channel Dredging & Shallow Dredging of 50% of the Lower Lake Area with on and offsite placement. Plate S-9. This alternative involves dredging deep channels into Soldwedel and Lake of the Woods. Further shallow dredging of approximately 50% of the two lower lakes would occur. Placement of material would be on the bank east of Soldwedel Lake, west of Lake of the Woods, into small geotube islands, and placement in the quarry site across Illinois Rt. 29.

S10 Enhanced Channel Dredging & Shallow Dredging of 100% of the Lower Lake Area with on and offsite placement. This alternative involves dredging deep channels into Soldwedel and Lake of the Woods. Further shallow dredging of approximately 100% of the two lower lakes would occur. Placement of material would be on the bank, east of Soldwedel Lake, west of Lake of the Woods, into small geotube islands, and placement in the quarry site across Illinois Rt. 29.

Table 3-? Southern Unit Alternative Plans

Alt. Plans	Name & Symbol	AAHU Output (Bluegill)	AAHU Output (Combined)	First Cost Const.	Annzed. Cost	Annzed Cost/ AAHU (Bluegill)	Annzed. Cost/ AAHU (Overall)
S0	No Action Alternative	0	0	\$ 0.0	\$ 0.0	\$0.0	\$ 0.0
S1	15.3 Acres of Dredging with Onsite Placement (Base Option) D1+P3+P4	9.8	14.7	\$3,807,586	\$245,795	\$25,081	\$16,720
S2	22.8 Acres of Dredging with Onsite Placement D2+P3+P4+P9	10.4	15.1	\$5,983,672	\$386,270	\$37,141	\$25,580
S3	37.0 Acres of Dredging with Onsite Placement D3+P3+P4+P9	16.1	19.4	\$7,798,072	\$503,397	\$31,266	\$25,948
S4	43.4 Acres of Dredging with Onsite Placement D4+P3+P4+P9	16.0	17.5	\$7,317,204	\$472,355	\$29,522	\$26,991
S5	37.0 Acres of Dredging with On and Offsite Placement D3+P3+P4+P6+P9	16.1	19.5	\$7,489,602	\$483,484	\$30,030	\$24,794
S6	43.4 Acres of Dredging with On and Offsite Placement D4+P3+P4+P6+P9	16.0	17.5	\$7,088,879	\$457,615	\$28,600	\$26,149
S7	37.0 Acres of Dredging with Offsite Placement D3+P6	16.1	20.8	\$6,555,157	\$423,161	\$26,283	\$20,344
S8	43.4 Acres of Dredging with Offsite Placement D4+P6	16.0	18.7	\$6,092,708	\$393,309	\$24,581	\$21,032
S9	Enhanced Channel & Shallow Dredging of 50% of the Lower Lake Area with On and Offsite Placement D5+P3+P4+P6+P9			\$8,369,557	\$540,288		
S10	Enhanced Channel & Shallow Dredging of 100% of the Lower Lake Area with On and Offsite Placement D6+P3+P4+P6+P9			\$12,438,231	\$802,937		

* Estimated by prorating all on site & all offsite placement

* Plans in Green are Best Buys, Yellows are Cost Effective, and Red is not Cost Effective

Table 3-? Shows the relative changes in habitat unit outputs by Alternative Plans for each species utilized in the HEP.

Table 3-? Habitat Units by Plan for the Southern Unit

Habitat Response to Alternative Plans

Southern Unit

		<i>Plans</i>										
		<i>S0</i>	<i>S1</i>	<i>S2</i>	<i>S3</i>	<i>S4</i>	<i>S5</i>	<i>S6</i>	<i>S7</i>	<i>S8</i>	<i>S9</i>	<i>S10</i>
<i>Species</i>	<i>Bluegill</i>	0	9.8	10.4	16.1	16	16.1	16	16.1	16		
	<i>Great Blue Heron</i>	0	-9	-8.3	-7.4	-9.4	-7.4	-9.4	-7.4	-9.4		
	<i>Marsh Wren</i>	0	13.8	12.7	10.5	10.7	10.5	10.7	12	12		
	<i>Wood Duck</i>	0	0.1	0.3	0.2	0.2	0.3	0.2	-0.1	-0.1		

b. Alternatives Plans for Northern Unit. The goals for the northern unit are to improve aquatic habitats, enhance wetlands, and terrestrial habitats through improved water level management, spawning and nursery habitats, water quality, migratory waterfowl and shorebird areas, enhanced heron feeding areas, diversity and extent of aquatic vegetation and protection of the heron and egret rookery. The alternatives are separated into two categories, water level management (“L” alternatives) and rehabilitation and sculpting (“M” alternatives). This was done because the rehabilitation and sculpting plans are independent stand-alone alternatives that do not require the water level management structures or water sources. Further, the water level management plans differ only in the source of water and are not dependent on rehabilitation and sculpting to generate habitat benefits.

The alternatives are:

L0 No Action Alternative

L1 Water Level Management with Pump & Well. Plate W7. This alternative involves placement of material, construction of a gate and spillway structure on the CILCO causeway, grading, and seeding of the levee structure. The low spots along the natural levee would be filled to facilitate water level management. A pump & well would be installed to deliver water supply to Worley Lake.

L2 Water Level Management with Natural Hydraulics. Plate L1. This alternative involves placement of material, construction of a gate and spillway structure on the CILCO causeway, grading, and seeding of the levee structure. The low spots along the natural levee would be filled to facilitate water level management. The natural river hydraulics will be used to fill Worley Lake.

M0 No Action Alternative.

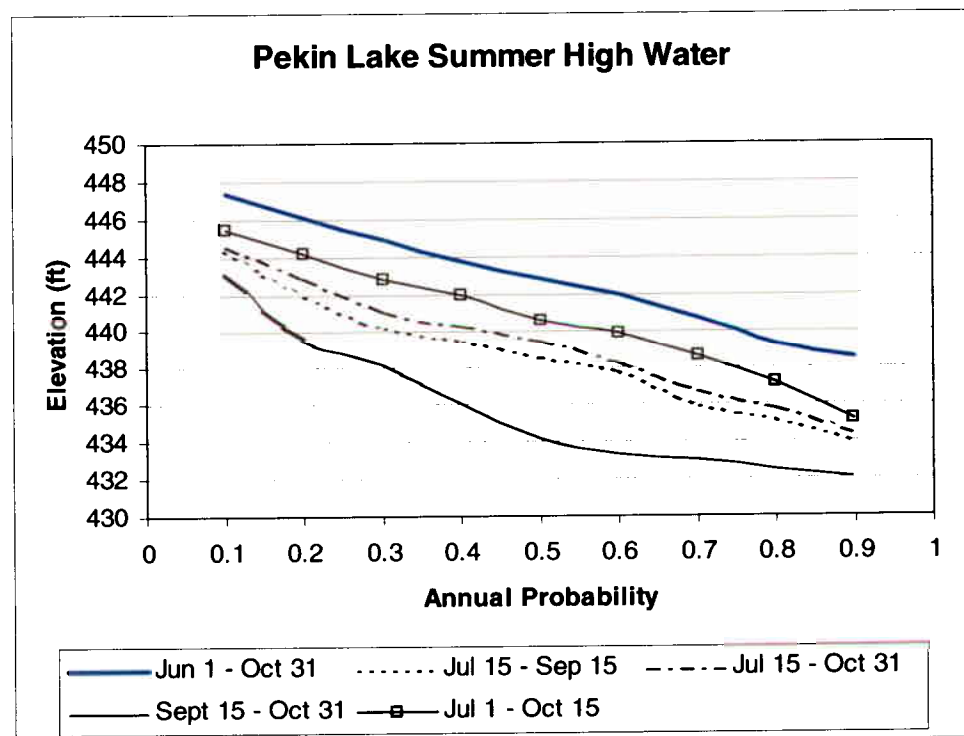
M1 Rehabilitate Slim Lake. Plate M1. This alternative involves removal of willows and shallow dredging Slim Lake. Material would be used to construct the water level management structure on the CILCO causeway.

M2 Sculpting for Drainage. Plate M2. This alternative involves sculpting of northern unit submerged contours to allow for complete drainage of upper unit to eliminate ponding during low water and/or drawdowns. Material would be used to construct the water level management structure on the CILCO causeway.

M3 Rehabilitation and Sculpting. This alternative combines M1 and M2.

The success of water level management in the Northern unit is guided by the following hydrologic assumptions. The water level recurrence for two new intervals: July 1 - Oct 15 and Sept 15 - Oct 31 is presented in Figure 3-?, below. This provides you the chances that water will overtop the given elevation in a given year. For example, taking 438 ft as our elevation, the graph indicates that water will exceed 438 ft at least once between July 1 and October 15 in about 75% of years, and at least once between September 15 and October 31 in about 30% of years. It is likely that the combination of a completely dry summer with a late season rise (assuming the 438 elevation) would occur less often than the 7.5% of the time predicted assuming that these factors are independent of each other.

Figure 3-?



Eight possible combinations exist among the alternatives available for implementation in the northern unit. These measures were combined into alternative plans that represent the full range of alternatives.

The alternative plans are:

Table 3-? Northern Unit Alternative Plans

Alt. Plans	Name	AAHU Output	First Cost Const.	Annual-ized Cost	Annualized Cost/AAHU
<i>N0</i>	No Action L0+M0	0	\$0	\$0	\$0
<i>N1</i>	Water Level Management and Natural Hydraulics L2+P2+M0	46.5	\$623,552	\$40,253	\$865
<i>N2</i>	Water Level Management, Natural Hydraulics, and Rehabilitate Slim Lake L2+P2+M1	51.3	\$852,226	\$55,015	\$1,072
<i>N3</i>	Water Level Management, Natural Hydraulics, and Sculpting for Drainage L2+P2+M2	50.3	\$623,552	\$40,253	\$800
<i>N4</i>	Water Level Management, Natural Hydraulics, Rehabilitate Slim Lake, and Sculpting for Drainage L2+P2+M3	55.8	\$852,226	\$55,015	\$985
<i>N5</i>	Water Level Management and Pump & Well L1+P2+M0	75.2	\$1,082,803	\$69,899	\$929
<i>N6</i>	Water Level Management, Pump & Well, and Rehabilitate Slim Lake L1+P2+M1	82.5	\$1,311,477	\$84,661	\$1,026
<i>N7</i>	Water Level Management, Pump & Well, and Sculpting for Drainage L1+P2+M2	78.3	\$1,082,803	\$69,899	\$892
<i>N8</i>	Water Level Management, Pump & Well, Rehabilitate Slim Lake, and Sculpting for Drainage L1+P2+M3	85.6	\$1,311,477	\$84,661	\$989

Table 3-? Shows the relative changes in habitat unit outputs by Alternative Plans for each species utilized in the HEP.

Table 3-? Habitat Units by Plan for the Northern Unit

Habitat Response to Alternative Plans
Northern Unit

		Plans								
		<i>N0</i>	<i>N1</i>	<i>N2</i>	<i>N3</i>	<i>N4</i>	<i>N5</i>	<i>N6</i>	<i>N7</i>	<i>N8</i>
Species	<i>Emergent Suitability</i>	0	40.6	46.3	38.3	44	69.3	76.8	66.3	73.8
	<i>Great Blue Heron</i>	0	5.9	5.9	12	12	5.9	5.9	12	12
	<i>Wood Duck</i>	0	0	-0.9	0	-0.2	0	-0.2	0	-0.2